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PSEUDOMORPHS OF KYANITE NEAR WINNSBORO, FAIRFIELD COUNTY, SOUTH CAROLINA[1]

By

W. C. Overstreet, E. F. Overstreet, and Henry Bell III

U. S. Geological Survey

Beltsville, Maryland

Two minor but geologically interesting and previously undescribed occurrences of pseudomorphs of kyanite in southern Fairfield County, South Carolina, were observed by the writers in September 1959. Both occurrences are spatially associated with the granite pluton southwest of Winnsboro, but the original kyanite is evidently older than the granite.

The granite pluton southwest of Winnsboro has been opened at several quarries. The character of the quarried rock is mentioned in the literature (Tuomey, 1848, p. 110-111; Derby 1891, p. 205-206; Sloan 1908, p. 209-213; and Watson, 1910, p. 185-189), but the outline of the pluton is not shown on old geologic maps. However, the characteristic soil developed on the granite, the Cecil coarse sandy loam, is readily distinguishable from the Georgeville silt loam, Iredell clay loam, and Cecil clay loam formed on the schistose wall rocks. The shape of the granite mass in southern Fairfield County is plainly indicated by a distinctive circular area of Cecil coarse sandy loam southwest of Winnsboro on a map of the soils of the county by M. E. Carr and others (1913, map). Clockwise from Winnsboro the outline of the area can be traced southeastward to Simpson, southwestward from Simpson to Browns Bridge, northwestward from Browns Bridge upstream along the Little River to the mouth of Jackson Creek, thence northeastward along Jackson Creek to Winnsboro. The circular outline thus formed defines the pluton, which is nearly 11 miles in diameter, and its shape strongly controls the local drainage pattern.

Exposures in streams and road cuts adjacent to and within the area underlain by the granite reveal that the marginal parts of the mass commonly contain angular and blocky inclusions of the wall rocks, which are principally biotite-muscovite schist, amphibolite, and sericite phyllite. Inclusions of quartzite occur at several places. At one locality, described below, inclusions of feldspathic kyanite-muscovite schist were found. Strong centripetal orientation of the inclusions and locally pronounced centripetal linear and planar features in the granite mass are interpreted by us to show that the pluton tapers downward in a funnel shape

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AND THAT FLOWAGE OF THE GRANITE WAS UPWARD FROM THE SMALL END OF THE FUNNEL.

INCLUSIONS OF FELDSPATHIC KYANITE-MUSCOVITE SCHIST ARE EXPOSED, TOGETHER WITH INCLUSIONS OF AMPHIBOLITE AND BIOTITE-MUSCOVITE SCHIST, IN FINE-GRAINED GRANITE IN THE DEEP ROAD CUTS 0.9 MILE SOUTHWEST OF BLACKJACK, IN THE NORTH-CENTRAL PART OF THE GRANITE MASS. NEARLY ALL THE ROCK IN THE CUTS, EXCEPT SOME SMALL MASSES OF AMPHIBOLITE, ARE SAPROLITE, BUT CONSPICUOUS GEOLOGIC DETAILS HAVE SURVIVED THE WEATHERING AND ARE PRESERVED IN THE SAPROLITE.

THE INCLUSIONS OF SCHIST ARE SHARPLY ANGULAR AND SLABBY. THEIR LONGEST AND WIDEST FACES ARE PARALLEL TO THE PLANE OF FOLIATION OF THE FRAGMENT, AND THEIR NARROW TERMINAL FACES ARE JOINTS. INTERIOR JOINTS PARALLEL TO THE TERMINAL FACES HAVE OPENED A FRACTION OF AN INCH IN SOME INCLUSIONS, AND GRANITE HAS PENETRATED THE OPENINGS WITH THE RESULT THAT SEVERAL LARGE INCLUSIONS ARE INCIPIENTLY RIFTED INTO A MOSAIC OF JOINT FRAGMENTS. THE STRIKE AND DIP OF THE FOLIATION OF THE INCLUSIONS RANGES FROM N. 60°W., 65°S. TO WEST, VERTICAL. BECAUSE THREE VARIETIES OF ROCK ARE RANDOMLY INTERMINGLED AS ANGULAR INCLUSIONS, AND BECAUSE THE INCLUSIONS ARE BROUGHT TO A HIGH STATE OF PREFERRED ORIENTATION WHEREBY THEY PARALLEL THE NEAREST EDGE OF THE PLUTON, SOME 3 MILES TO THE NORTHEAST, AND DIP TOWARD THE CENTER OF THE PLUTON, 2.5 MILES TOWARD THE SOUTH-SOUTHWEST, WE THINK THEY ARE MAGMATICALLY MOVED AND ORIENTED FRAGMENTS OF THE WALLS.

CONTACTS BETWEEN THE GRANITE AND THE INCLUSIONS ARE SHARP. NO CHANGE IN GRAIN SIZE OR COMPOSITION OF THE GRANITE IS APPARENT EITHER AGAINST THE WALLS OF THE INCLUSIONS OR IN JOINTS IN THE INCLUSIONS. NO REACTION BETWEEN THE GRANITE AND THE AMPHIBOLITE OR BIOTITE-MUSCOVITE SCHIST WAS OBSERVED, BUT THE FELDSPATHIC KYANITE-MUSCOVITE SCHIST HAS UNDERGONE CONSIDERABLE CHANGE. THE FELDSPATHIC KYANITE-MUSCOVITE SCHIST CONSISTS OF A MIXTURE OF FELDSPAR (WEATHERED TO KAOLINITE IN THE SAPROLITE EXPOSURES), MUSCOVITE, AND MUSCOVITE PSEUDOMORPHS AFTER RADIAL SHEAVES OF KYANITE. THE RADIAL SHEAVES OF KYANITE ARE FLAT IN THE PLANE OF FOLIATION. THEY ARE 0.7 INCH TO 1 INCH IN DIAMETER, 0.05 INCH TO 0.1 INCH THICK, AND ARE COMPOSED OF THIN, RADIALLY ARRANGED, BLADES OF KYANITE 0.3 TO 0.5 INCH LONG AND 0.02 TO 0.04 INCH WIDE. NOTHING IS LEFT OF THE ORIGINAL KYANITE. ONLY FINE-GRAINED SILKY WHITE TO PALE-GREEN MUSCOVITE CAN BE SEEN IN THE BLADES AND AGGREGATES. X-RAY DIFFRACTION PATTERNS OF THE MATERIAL FORMING THE RADIAL AGGREGATES REVEALED ONLY MUSCOVITE AND A TRACE OF HYDROBIOTITE (BRINDLEY, 1951, P. 212-215, 222). IDENTIFICATION OF THE RADIAL SHEAVES OF KYANITE RESTS ON THE

RESEMBLANCE OF THE PSEUDOMORPHS TO COMMON SHAPES OF KYANITE. RANDOMLY ORIENTED, COARSE-GRAINED, SIEVE-TEXTURED, WHITE TO PALE-GREEN MUSCOVITE METACRYSTS CUT ACROSS THE FOLIATION PLANES AND CUT THROUGH THE RADIAL AGGREGATES OF FINE-GRAINED MUSCOVITE PSEUDOMORPHIC AFTER KYANITE. WE INTERPRET THESE RELATIONS AS SHOWING THAT FELDSPATHIC MUSCOVITE SCHIST WAS FORMED FROM PELITE OR FELSIC VOLCANIC ROCK DURING REGIONAL METAMORPHISM, AND THAT AT THE PEAK OF METAMORPHISM THE RADIAL AGGREGATES OF KYANITE FORMED ON THE FOLIATION PLANES OF THE SCHIST. THE SCHIST WAS SUBSEQUENTLY INTRUDED BY THE PLUTON OF GRANITE, AND FRAGMENTS OF THE SCHIST WERE INCLUDED IN THE GRANITE. THE ENVIRONMENT OF REACTION BETWEEN THE GRANITE AND THE INCLUSION PROVIDED ADEQUATE WATER, POTASSIUM, AND SILICA COMPLETELY TO CONVERT THE KYANITE TO FINE-GRAINED PSEUDOMORPHIC MUSCOVITE AND TO GENERATE COARSE-GRAINED CROSS-CUTTING METACRYSTS OF MUSCOVITE (RAMBERG, 1952, P. 227).

SIMILAR MUSCOVITE PSEUDOMORPHS AFTER KYANITE ARE EXPOSED IN ROADSIDE OUTCROPS OF KYANITIC QUARTZITE AND KYANITIC MUSCOVITE SCHIST IN A RE-ENTRANT ALONG THE WEST WALL OF THE GRANITE PLUTON 1.2 MILES SOUTH-SOUTHEAST OF ANDERSON QUARRY. THE KYANITIC QUARTZITE AND MUSCOVITE SCHIST TREND N.40°E., 85°SE. TO N.50°E., 90°, INTO THE RE-ENTRANT. ON THEIR SOUTHEASTERN SIDE THE KYANITIC ROCKS ARE BOUNDED BY GRANITE, AND ON THEIR NORTHWESTERN SIDE THEY JOIN A SEQUENCE OF FELDSPATHIC SCHISTS AND THIN-BEDDED, FELDSPATHIC AMPHIBOLITE. HERE ALSO THE ROCKS ARE THOROUGHLY WEATHERED TO SAPROLITE. EVEN THE KYANITIC QUARTZITE IS DEEPLY LEACHED. THE APPEARANCE OF THE NONGRANITIC SAPROLITE, WHICH IS A SUCCESSION OF METAMORPHOSED SEDIMENTS AND MAFIC VOLCANIC ROCKS, STRONGLY RESEMBLES THE MORE HIGHLY METAMORPHOSED PARTS OF THE VOLCANIC-SEDIMENTARY SLATE BELT OF WHICH THE NEAREST RECOGNIZABLE EXPOSURES ARE ABOUT 2.5 MILES TO THE SOUTH.

THE KYANITIC QUARTZITE AND KYANITIC MUSCOVITE SCHIST ARE INTERBEDDED. THEY ARE EXPOSED FOR A DISTANCE OF 70 FEET ALONG THE ROAD. INASMUCH AS THEY STAND ABOUT VERTICAL AND STRIKE NEARLY AT RIGHT ANGLES TO THE DIRECTION OF THE ROAD, THEIR EXPOSED WIDTH IS PROBABLY ONLY A LITTLE GREATER THAN THEIR TRUE THICKNESS. THE TOTAL LENGTH OF THE KYANITIC ROCKS IS NOT KNOWN TO US. WE INFER FROM THE SOILS MAP THAT THEY PROBABLY EXTEND ONLY A FEW HUNDRED FEET SOUTHWESTWARD BEFORE THEY ARE INTERSECTED BY GRANITE. THEIR EXTENT TOWARD THE NORTHEAST, JUDGING BY THE SAME MAP, COULD BE AS MUCH AS 0.3 MILE BEFORE THEY ARE CUT ACROSS BY GRANITE, BUT IN THE ROAD CUT NO EVIDENCE COULD BE FOUND THAT THEY HAVE ANY CONTINUITY TOWARD THE NORTHEAST. BECAUSE THE GRANITE IS IN CONTACT WITH THEM AT THE ROAD, IT MAY CUT THEM OUT WITHIN A FEW SCORE FEET TOWARD THE NORTHEAST.

Tabular and bladed aggregates, rarely exceeding 0.4 inch in width and 0.8 inch in length, and fibrous sheaves, up to 0.8 inch in length, of what was once kyanite are now wholly replaced by white, gray, or bright-green muscovite. The bright-green muscovite resembles in color the grass-green kyanite found by J. H. Pratt (1898, p. 126) in weathered mica schist on the Tiel Young farm near the North Toe River, Yancey County, N. C. X-ray diffraction studies of the green aggregates from the schist and quartzite south of Anderson Quarry, S. C., disclosed only muscovite and a small amount of hydrobiotite (Brindley, 1951, p. 212-215, 222). The tabular and bladed aggregates and fibrous sheaves of muscovite pseudomorphic after kyanite make up as much as 20 or 30 percent of the rock, but they probably average about 10 percent of the quartzite and 15 percent of the muscovite schist. The mineralogical and structural relations observed at this locality we interpret to mean that original kyanite in the quartzite and schist was completely converted to muscovite by contact action of the granite.

Samples from both localities where kyanite was altered to muscovite contain only muscovite. The alteration of the kyanite is complete. The pseudomorphs do not show chlorite or pyrophyllite, nor do they show sillimanite when examined by X-ray methods. However, kyanite incompletely altered to pyrophyllite is known (H. S. Johnson, Jr., 1959, unpublished data) at Little Mountain, Newberry County, in the volcanic-sedimentary slate belt only 13 miles southwest of the kyanite pseudomorph locality south of Anderson Quarry. Kaynite completely altered to sillimanite was found by D. B. Potter 2/ along the west contact of the Yorkville quartz monzonite in York County about 55 miles north of Anderson Quarry. We infer from the alteration of the kyanite exposed near Winnsboro that the contact reactions took place in a hydrous and potassic environment at temperatures too high for chlorite or pyrophyllite to form and too low for sillimanite to form or kyanite to be preserved. Thus, the kyanite at Winnsboro was altered under conditions of temperature more severe than those that obtained at Little Mountain and less high than those at the contact of the Yorkville quartz monzonite in York County.

2/ Potter, D. B., 1954, High alumina metamorphic rocks of the Kings Mountain district, North Carolina and South Carolina: Doctoral dissertation California Inst. Technology, p. 1-204.

REFERENCES CITED

Brindley, G. W., 1951, X-ray identification and crystal structures of clay minerals: London, The Mineralogical Society (Clay Minerals Group), p. 1-345.

Carr, M. E., Welsh, F. S., Crabb, G. A., Allen, R. T., and Byers, W. C., 1913, Soil survey of Fairfield County, South Carolina: U. S. Bur. Soils, Advance sheets, field operations 1911, p. 3-37, map.

Derby, O. A., 1891, On the separation and study of the heavy accessories of rocks: Rochester Acad. Sci. Proc., v. 1, brochure 2, p. 198-206.

Pratt, J. H., 1898, Mineralogical notes on cyanite, zircon, and anorthite from North Carolina: Am. Jour. Sci., ser. 4, v. 5, no. 26, p. 126-128.

Ramberg, Hans, 1952, The origin of metamorphic and metasomatic rocks: Chicago, The University of Chicago Press, p. 1-317.

Sloan, Earle, 1908, Catalogue of the mineral localities of South Carolina: South Carolina State Devel. Board, Div. Geol., reprint, p. 7-505 (1958).

Tuomey, Michael, 1848, Report on the geology of South Carolina: Columbia, South Carolina, A. S. Johnston, p. 1-293.

Watson, T. L., 1910, Granites of the southeastern Atlantic states: U. S. Geol. Survey Bull. 426, p. 3-282.

A PRELIMINARY REPORT ON THE GABBROS OF NEWBERRY COUNTY, SOUTH CAROLINA

By

J. F. McCauley 1/

Introduction

Recent investigations in Newberry County, S. C., under the sponsorship of the S. C. Division of Geology, have resulted in the discovery of three gabbro intrusives of a type known to occur elsewhere in the Piedmont but as yet inadequately described. These intrusives are located within the Charlotte Belt plutonic complex described by King (1955). They are moderately well exposed in an area usually considered poor in natural outcrops. Large, remarkably fresh, residual boulders are present at many localities, as well as fresh bedrock terraces along the flanks of stream valleys. Where deeply weathered, a brownish black unctious soil is present, the extent of which provides a realiable estimate of the size and shape of the bodies.

General Geology

The three gabbro bodies so far discovered differ considerably from one another in their general form and setting (Figure 1). To the northeast of Newberry, a relatively thin arcuate dike crops out discontinuously for a total distance of about four miles. Its thickness varies from about twenty feet to about two hundred feet. One half mile east of the junction of Routes 76 and 34 its attitude can be measured in the roadcut. The strike is N.70°E., the dip 70°N., toward the inside of the cresent-like outcrop pattern. This intrusive is apparently cut by a northwest-trending diabase dike of the type generally considered to be Triassic in age. Contacts between the two bodies could not actually be observed, but float from the Triassic (?) dike can be traced across the projected outcrop of the gabbro, exposed a few hundred feet on either side of the diabase.

The intrusive to the northwest of Newberry also appears to be arcuate in shape and crops out over a comparable distance but with considerably greater thickness. The contacts of this body are not well exposed so that the form shown in Figure 1 may need revision upon further study. Both this body and the cresent shaped gabbro dike are intrusive into massive or weakly foliated granodiorite which is itself in-

1/Professor of Geology, University of South Carolina

TRUSIVE INTO THE MIGMATIZED GNEISSES AND AMPHIBOLITES OF THE CHARLOTTE BELT.

THE GABBRO TO THE WEST OF NEWBERRY IS ROUGHLY TRIANGULAR IN SHAPE AND CUTS CHARLOTTE BELT GNEISS RATHER THAN GRANODIORITE. THE EASTERNMOST CONTACT OF THIS BODY CAN BE SEEN ALONG COUNTY ROAD 58. PEGMATITIC STRINGERS CUT INTO THE GABBRO AT THIS POINT AND A PEGMATITE SEVERAL FEET ACROSS WAS OBSERVED AT "X", WELL WITHIN THE MARGINS OF THE PLUG. THESE FEATURES COULD BE OF RHEOMORPHIC ORIGIN, BUT MORE PROBABLY INDICATE THAT SOME ACID MAGMATIC ACTIVITY POSTDATED THE EMPLACEMENT OF THESE RELATIVELY LATE CYCLE GABBROS.

PETROGRAPHY

THREE VARIETIES OF BASIC ROCK HAVE BEEN NOTED FROM THE INTRUSIVES. MOST GENERALLY OBSERVED IS A MEDIUM- TO COARSE-GRAINED GREENISH-PURPLE ROCK PRESENT IN ALL THREE BODIES. ONE EXPOSURE OF A MEDIUM GRAINED BROWNISH GRAY ROCK WAS NOTED JUST TO THE EAST OF "X". WEATHERED EXPOSURES OF A ROCK VERY SIMILAR TO THE GREENISH PURPLE VARIETY WERE LOCATED AT "Z". THIS ROCK, HOWEVER, CONTAINS A PREPONDERENCE OF FELDSPAR IN CONTRAST TO THE GREENISH FERROMAGNESIANS, MORE COMMON TO THE FIRST TYPE.

THIN SECTION STUDY OF THIS GREENISH GABBRO REVEALS THE PRESENCE OF MINOR REMNANTS OF DIALLAGE, THE FERROAN VARIETY OF DIOPSIDE, EXTENSIVELY URALITIZED BY FIBROUS ACTINOLITE. SOME BROWN TO GREENISH HORNBLENDE IS PRESENT WHICH ALSO APPEARS TO BE A REPLACEMENT OF EARLIER PYROXENE MINERALS. THE PLAGIOCLASE IS WELL TWINNED ACCORDING TO THE CARLSBAD, ALBITE, AND PERICLINE LAWS. ITS INDICES OF REFRACTION RANGE BETWEEN 1.55 AND 1.57 AND ITS COMPOSITION IS INFERRED TO BE AN 50 ± 5. THIS PLAGIOCLASE IS GENERALLY SAUSSURITIZED BY GRANULAR AGGREGATES OF EPIDOTE AND FIBROUS CHLORITE WHICH, HOWEVER, ALSO REPLACES THE FERROMAGNESIAN MINERALS. SOME QUARTZ, CALCITE AND CLINOZOISITE ARE LIKEWISE ASSOCIATED WITH THE ALTERATION. OPAQUE MINERALS INFERRED TO BE ILMENITE OR HEMATITE ARE PRESENT AS MINUTE ORIENTED LAMELLAE WITHIN HORNBLENDE AND PLAGIOCLASE CRYSTALS. DISSEMINATED IRREGULAR CRYSTALS OF PYRITE ARE GENERALLY PRESENT.

CONCLUSIONS

INITIAL RECONNAISSANCE WORK ON THE GABBRO INTRUSIVES IN THE NEWBERRY AREA INDICATES THE PRESENCE OF A ROUGHLY TRIANGULAR PLUG, AN IRREGULAR BUT GENERALLY ARCUATE PLUG AND A THIN BUT REMARKABLY CONTINUOUS CRESENT SHAPED DIKE. THE

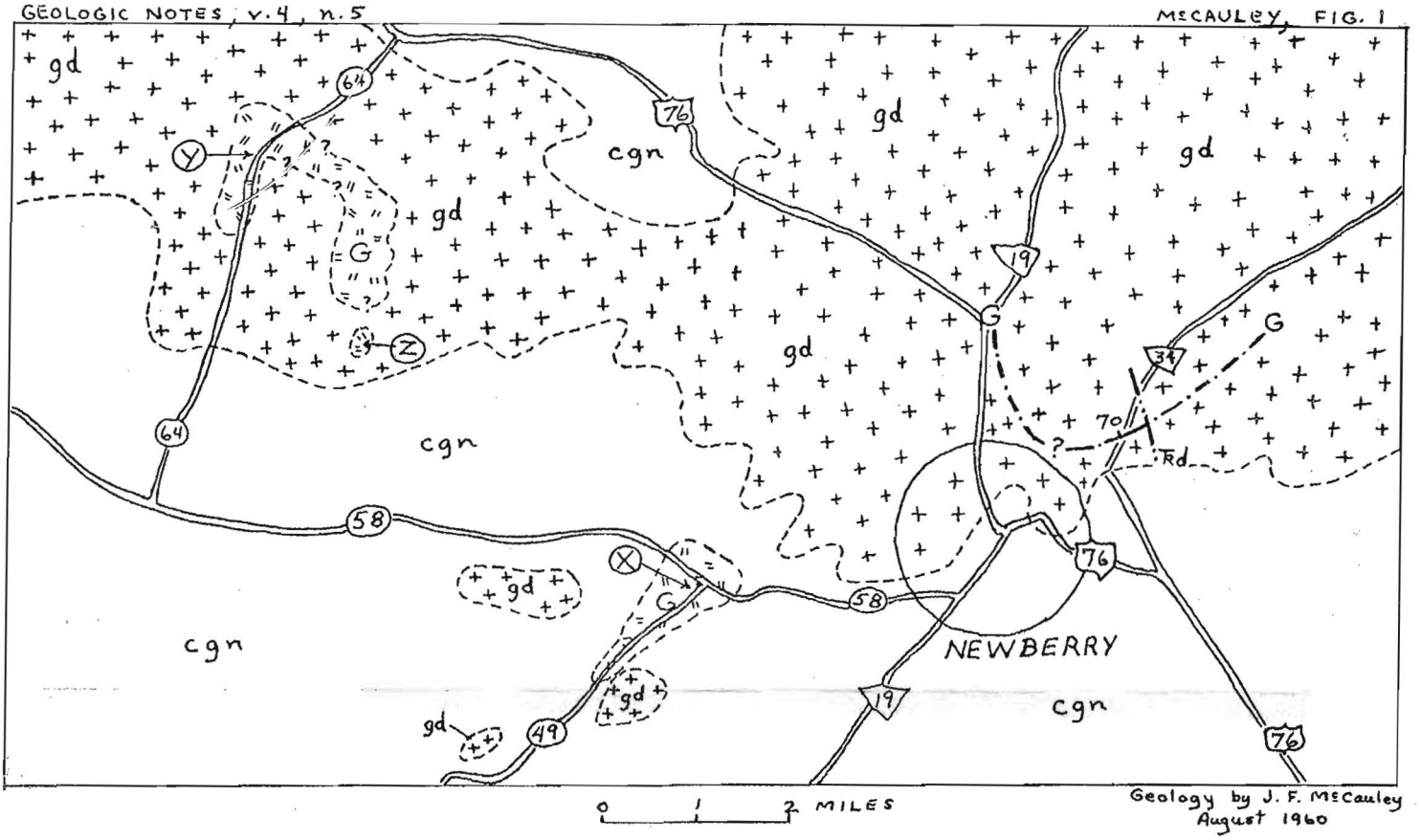
ARCUATE AND CRESENT SHAPED BODIES ARE PROBABLY RING DIKES WHEREAS THE TRIANGULAR BODY REPRESENTS A CENTRAL PLUG EMPLACED AT A HIGHER LEVEL THAN THE OTHER TWO. THESE BODIES ARE INTRUSIVE INTO THE GRANODIORITE AND MIGMATITIC GNEISS OF THE CHARLOTTE BELT AND ARE CUT BY DIABASE OF TRIASSIC (?) AGE. ALTHOUGH GENERALLY LATER THAN THE METAMORPHIC CLIMAX IN THE AREA THEY ARE ALSO CUT BY PEGMATITES AND EXTENSIVELY URALITIZED AND SAUSSURITIZED. IF THE PEGMATITES ARE NOT RELATED TO THE MOBILIZATION OF THE WALL ROCK DURING AND AFTER GABBRO EMPLACEMENT, IT CAN BE INFERRED THAT AT LEAST SOME ACID MAGMATIC ACTIVITY POSTDATED THE EMPLACEMENT OF THESE BASIC INTRUSIVES.

ECONOMIC CONSIDERATIONS

THE MEDIUM TO COARSE PHASE OF THE GREENISH-PURPLE ROCK MAKES AN EXTREMELY ATTRACTIVE STONE WHICH MIGHT BE SUITABLE FOR INTERIOR DECORATION AS WELL AS EXTERIOR FACINGS. AT "Y" IN FIGURE 1 A BEDROCK TERRACE SEVERAL HUNDRED FEET IN EXTENT IS PRESENT. TWO MODERATELY WELL DEVELOPED SETS OF STEEPLY DIPPING JOINTS (N.10°E., AND N. 80°W.) ALONG WITH A FOLIATION, N - S, 40°W., WERE NOTED AT THIS LOCALITY. THE FRESHNESS OF THE ROCK AT THE IMMEDIATE SURFACE AND THE PRESENCE OF THE JOINTS AND FOLIATION SUGGEST THAT THIS LOCATION MIGHT BE SUITABLE FOR A MODEST QUARRY OPERATION. RAIL TRANSPORTATION IS AVAILABLE TWO MILES NORTH OF THE SITE OVER A GOOD ALL WEATHER ROAD.

REFERENCES CITED

KING, P. B., 1955, GUIDES TO SOUTHEASTERN GEOLOGY: GUIDEBOOK FOR 1955 ANNUAL MEETING OF GEOL. SOC. OF AMERICA, P. 346-350.



EXPLANATION

Rd	Diabase dike of Triassic (?) age	TRIASSIC (?)
G	Gabbro dike	PALEOZOIC (?)
"G"	Massive to weakly banded gabbro	
gd	Massive to weakly foliated granodiorite	
cgn	Interbedded and migmatized quartz-biotite gneiss of the Charlotte Belt	

FIG. 1 GEOLOGIC MAP OF PART OF NEWBERRY COUNTY, SOUTH CAROLINA